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ABSTRACT

Results of 2 years of applying microcomputing technology in a college freshman English program at a medium-sized university are reported. Using a cross-factorial research design, six instructors and six control and six experimental sections were studied to determine the cognitive, pedagogic, and financial implications of the microcomputer application. Attention was directed to the effects of word processing on: student composition skills; faculty time spent in teaching, class preparation, grading, and student consultation; student-faculty interaction; and costs of creating and operating a microcomputing lab facility. Findings include: students not using word processing outperformed students using this technology as measured by the standard Houghton-Mifflin College English Placement Exam; instructors spent about 22% more time with the word processing section compared to the section not using this equipment; the average cost per computer workstation hour per student was 39 cents, or $468 per semester for a section of 25 students. Cognitive data from the previous year showed the word processing section outperforming the control group section. (SW)

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Cognitive, Pedagogic, and Financial Implications of Word Processing in a Freshman English Program: A Report on Two Years of a Longitudinal Study

presented by

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The Association for Institutional Research
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COGNITIVE, PEDAGOGIC, AND FINANCIAL IMPLICATIONS OF WORD PROCESSING IN A COLLEGE FRESHMAN ENGLISH PROGRAM: A REPORT ON TWO YEARS OF A LONGITUDINAL STUDY

ABSTRACT

Despite nearly two decades of experience in the application of educational technology in college and university settings, little is known about the technology's impact(s) on the student, the instructor, or the university.

This study reports the results after two years of application of microcomputing technology in a freshman English program in a medium-sized midwestern university. A cross-factorial research design with six control and six experimental sections, and six instructors were observed to determine the cognitive, pedagogic, and financial implications of the application of microcomputers and widely-available software in a college freshman English program.

Results should be generalizable to other similar programs, and can serve the administrator considering the application of this form of educational technology by providing indications of some of the changes experienced.

AIR
for Management Research, Policy Analysis, and Planning

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Ann K. Dickey, Chair
Forum Publications Editorial
Advisory Committee

Introduction

Papert (1982) has suggested that the most important thing American educators could do to improve writing in this country would be to give every fifth grader a word processor. Tickton (1970), reporting on behalf of the Commission on Instructional Technology which examined educational technologies concluded:

> In the conviction that technology can make education more productive, individual, powerful, make learning more immediate, give instruction a more scientific base, and make access to education more equal, the Commission concludes that the nation should increase its investment in instructional technology, thereby upgrading the quality of education, and ultimately, the quality of individuals' lives and of society generally (p. 10, Vol.1).

Strange (1983) summarized the likely consequences which changing technology would have on education by 1987 by saying that by that time 80 percent of all post-secondary students, 50 percent of all secondary students, 40 percent of faculty at all levels, and 30 percent of all fifth graders will be using word processors regularly.

More recently, Becker (1984) reported that between mid-1981 and the fall of 1983, the percentage of elementary schools with one or more microcomputers jumped from 10 percent to over 60 percent. During that same period, the percentage of secondary schools with five or more microcomputers grew from 10 percent to well over 50 percent. According to Becker, the amount spent by schools on computers and related software and hardware in 1983

may have been as much as one-third the amount spent on books for instruction in all subjects and all grade levels combined.

In a follow-up study, Becker (1986) reported that today the majority of U.S. elementary schools have five or more computers. As compared to the 1984 report when most American secondary schools have fewer than a handful of microcomputers, today, half of U.S. schools have enough computers to serve between one-half and one full classroom of students at one time. While there has been a quadrupling of the number of computers in schools in the past two years, there has been a tripling of the number of students using computers and a tripling of the number of teachers supervising students in their use.

The dilemma that increased use of computers presents to higher education administrators is one of determining which of these technological advances should be applied to curricula, and what are the likely outcomes, particularly in terms of return on investments. Levin (1984) issued a warning to administrators and others, saying:

> ...popular assumptions about costs and cost-effectiveness of computer assisted instruction (CAI) are often not supported by evidence. To the degree that decisions to adopt CAI are made on the basis of such assumptions, they may be costly and inefficient. It is critical that systematic evaluation of CAI proceed as rapidly as the proliferation of computers in instruction in order to ascertain the most promising applications in a framework which considers both their educational effectiveness and costs.

Given the situation of uncertainty of gains in the application of microcomputers (or computers in general) to a wide range of academic uses, the University of Wisconsin-Stevens Point has sought to unravel some of this mystery. Beginning in the fall 1984 semester, data have been collected from several sections of the freshman English program with regard to the implications of electronic text processing. The present study presents the results of the analysis of these data, with emphasis on the most recent semester. While considerable data have been collected, this study reports on those specific to cognitive, pedagogic, and financial variables.

It is felt that because our university is similar in many respects to a large number of other universities in the U.S., that it is an ideal setting for such a study. UWSP is a public, four-year university with selected masters level programs. Its fall 1985 enrollment was approximately 9,200 (headcount); its major programmatic emphasis is on the liberal arts.

PURPOSE

This study examines data collected during fall 1985 and addresses three major questions:

1. What effect does word processing have on students of freshman English composition?
   a. What changes occur in general composition skills?
   b. What changes occur in specific composition skills?

2. What effect does word processing have on instructors?
   a. What are the time-related effects of this approach?

b. What pedagogic changes do instructors make in their approach to teaching?
c. What effect does this teaching technique have on communication between faculty and student?

3. What is the financial impact of the application of this technology on the university?

DATA SOURCES

Student-specific data were gathered with two instruments. The Houghton-Mifflin College English Placement Test was used to ascertain measures of specific writing skills. An holistically evaluated, criteria-referenced essay writing assessment was used to determine general writing skills.

Faculty data were gathered from diary entries made by the six faculty involved in the experiment. Included were reports of time spent by instructors in: 1) class preparation; 2) in-class instruction; 3) assignment grading, and ; 4) student consultation.

Financial data were gathered from university financial records, and report, as suggested by Levin, data other than would be found in an accountants report.

METHODOLOGY

A cross-factorial design was employed with six control and six experimental sections of the freshman English composition program. Approximately twenty-five students were assigned to each section for a total N of 300. Sections were established using a matched-subjects (Wynne, 1982) technique to ensure that all sections were balanced with regard to general writing skills at the beginning of the experiment. All sections used the same course syllabi,

and all papers were required to be typed. Times of course offerings were randomly distributed to minimize extraneous effects. Each instructor taught one experimental and one control section of freshman English composition. Pretests and post-tests for general and specific writing skills were administered to all sections.

Financial data were gathered and examined by applying Levin's (1984) "ingredients approach." Five sets of financial data examined were: 1) personnel costs; 2) hardware costs; 3) software costs; 4) maintenance costs; 5) facilities costs.

THE ENVIRONMENT

To minimize course differences between control and experimental sections, all classes followed the same syllabus and all papers for the classes were required to be typed. Although control group participants were not prohibited from using the word processing equipment, few elected to do so.

Both control and experimental sections met in the traditional classroom environment for class lectures. However, for writing assignments (both in and out-of-class) the experimental group activities were accomplished in the microcomputer lab. Instructors controlled as much as possible class time differences so that if the experimental group worked on the microcomputing equipment during class time, the control sections worked on an identical in-class exercise.

At the beginning of the semester, the experimental group was provided introductory training in the use of the microcomputer lab facilities. To compensate for this, control sections spent additional time in discussions of course goals and objectives, grading policies, and correction symbols.

The Microcomputer Lab. During the second year of the experiment the number of microcomputers was expanded from twelve to 20 to accommodate the additional number of students in the second year of the experiment. As was the case last year, all software was stored on the network controller disk and downloaded with a few simple commands to the student microcomputer when needed.

The word processing package used in both years has been WordStar. This package was selected because it allowed the introduction of text manipulation functions of increasing complexity in a series of carefully graduated stages. The package also allowed the student to "grow into" complex formatting and printing options as the needs arose.

In order to assure minimum interruption of experimental group students in the use of microcomputing facilities, a lab assistant was always on duty to assist with technical problems. In addition, experimental group students were given first priority in the use of these facilities over other university students.

FINDINGS

Effects of Word Processing on Students

General Composition Skills. General composition skills were determined by pre and post administration of a holistically evaluated criteria-referenced essay writing assessment. Possible results of this assessment were numeric scores ranging from 0-8, as follows:

0 - remedial English recommended
1 - minimal sentence skills
2 - average sentence skills
3 - minimal paragraph skills
4 - average paragraph skills
5 - minimal essay skills
6 - average essay skills
7 - superior essay skills
8 - exempt-achieved full course objectives

Specific Composition Skills. The Specific Composition Skills were measured by a standard College English Placement Exam, the Houghton-Mifflin. This exam consists of 106 questions which parallel the usual steps in writing a composition. It is widely used to measure reliably and quickly a student's ability to use the English language effectively. Scores are percentages ranging from zero to 100.

In the evaluation of the results of the current data, several questions were asked. First, we wanted to know if the control and experimental group individually experienced a significant scores change between the pre and posttest evaluations. Secondly, we wanted to know if there were significant differences between the control and

experimental groups on either the general or the specific writing skills assessments.

Table 1 shows the results of the examination of Writing Skills Assessment of the Experimental and Control Groups. Data reported here only for those students for whom all test scores were available. The purpose of this table is to examine what change took place in scores from pretest to posttestin both of these groups. A t-test of the mean pre- and posttests for each group revealed that a significant change in scores did occur in both groups.

TABLE 1

Writing Skills Assessment
(Within Group Analysis)

	EXPERIMENTAL		CONTROL	
	PRE	POST	PRE	POST
N	95	95	98	98
Mean	3.1	4.0	3.3	4.1
S.D.	1.0	1.2	1.0	1.1
S.E.	10.7		12.8	
t-value	8.4*		6.6*	

*significant at the $p < .05$ level

The question of whether a significant change in scores occurred within the experimental and control groups on specific writing skills was accomplished by examining the t-values of the mean scores of both pre-and posttests of the Houghton-Mifflin. These results are presented in Table 2, and indicate that both groups experienced a significant change in specific writing skills as reported by the Houghton-Mifflin.

TABLE 2

Houghton-Mifflin

(within Group Analysis)

	EXPERIMENTAL		CONTROL	
	PRE	POST	PRE	POST
N	95	95	98	98
Mean	56.5	62.9	57.0	66.8
S.D.	13.5	11.9	12.7	11.0
S.E.	95.6		102.0	
t-value	6.4*		9.4*	

*significant at $p < .05$ level

The next question was whether there was a significant difference between the two groups on either of these measures of writing ability. These findings are reported in Table 3 for the general writing skills, and Table 4 for the specific writing skills. Data are reported here for all participants.

TABLE 3

WRITING SKILLS ASSESSMENT
(between groups analysis)

	PRETEST		POSTTEST	
	Exper.	Control	Exper.	Control
N	120	124	121	128
Mean	3.1	3.2	4.0	4.1
S.D.	1.0	0.9	1.2	1.2
S.E.	0.1	0.1	0.1	0.1
d.f.	242		247	
t-value	1.1		0.7	

TABLE 4

HOUGHTON-MIFFLIN
(between groups analysis)

	PRETEST		POSTTEST	
	Exper.	Control	Exper.	Control
N	128	133	106	108
Mean	56.1	57.0	62.7	66.2
S.D.	13.0	12.7	12.1	10.1
S.E.	1.1	1.1	1.2	1.1
d.f.	259		212	
t-value	0.57		2.3*	
probability	0.57		0.025	

These results indicate that while there was not a significant difference between the control and experimental group on the pre-to-post assessment of general writing skills, there was a significant difference in their specific writing skills as measured by the Houghton-Mifflin.

Table 5 carries this analysis between groups further by examining the actual distribution of scores on the Houghton-Mifflin.

TABLE 5
DISTRIBUTION OF HOUGHTON-MIFFLIN
SCORE CHANGES

	EXPERIMENTAL	CONTROL
Decreased	24%	16%
1-10 Point increase	50%	41%
11-20 Point increase	19%	26%
More than 20 pt. gain	7%	17%

Effect of Word Processing on Faculty

Time-Related Impact. Logs of instructor activity were kept throughout the semester to report time spent on four major activities: teaching; class preparation, grading, and; student consultation. Since all instructors followed identical syllabi, it was hypothesized that there would be no significant difference in mean amounts of time spent by instructors with control and experimental group activities. Actual mean times are shown in Table 6.

TABLE 6

MEAN INSTRUCTOR HOURS SPENT per SECTION IN TEACHING, CLASS PREPARATION, GRADING, STUDENT CONSULTATION

	CONTROL	EXPERIMENTAL	t-value
Teaching	48.7	56.5	-4.71
Grading	73.5	82.5	-3.95
Class Preparation	40.2	55	-5.05
Student Consultation	36.3	44.5	-4.04
TOTAL	195.8	238.5	-13.63

As can be seen, there was in fact significant differences(at $p < .05$ level) between all times spent by instructors in the control versus experimental group activities.

Pedagogic Changes. As in the prior year of this study, instructors continue to report changes in the teaching process when using word processors. A part of that is the

time necessary to instruct those in the experimental groups on the basics of computing usage. The added time is reflected in Table 3, but reveals only a part of the changes reported by instructors.

Another pedagogic change instructors are making relates to student-faculty interaction. Students in the experimental group frequently received instructor communications directly from the computer network rather than relying entirely on in-class instructions. Such communication, although not necessarily reflected in improved scores, does add a new dimension to the traditional faculty-student interaction.

Also, as reported in the first year of this study, student conferences with experimental group students lasted considerable longer, and tended to involve more "meaningful dialogue" between student and faculty member. As students came into the conference, they brought their diskette of writings. Loaded into the faculty member's microcomputer, the student and faculty member discussed the latest writings and what could be done to improve them. Then, with the aid of the word processing text processor software, the student could implement faculty suggestions while the faculty member assisted. Such student-faculty conferences were more enthusiastically attended than was the traditional conference. While this additional time in conference is surly reflected in the time reports filed by faculty, immediate results do not appear in the experimental students' Houghton-Mifflin scores.

The Effect of Word Processing on the University

Financial Impact. Through the application of Levin's "ingredients approach", a detailed examination was made of the financial impact of the word processing facilities on the university. According to Levin, all costs must be reported with this approach, and may result in different values than the more traditional accounting approach which reports a cost only if a budgetary transaction occurs. In this study, because of limited availability of costs related to alternative uses of building resources, cost estimates for these were used. These will likely vary from campus to campus, and should not be viewed as similar on other campuses

The total costs for the creation and operation of the microcomputing lab facility used in this study are shown in Figure 4.

Table 7

Local Area Network Costs Over a Four Year Life Expectancy

I. Initial Investment		
A. Network controller	$10,965	
B. Network cards, software	10,570	
C. Printers (2)	2,970	
D. Personal Computers (20)	42,693	
Total Initial Investment		$67,198
II. Annual Recurring Costs		
A. Equipment maintenance	5,300	
B. Support staff	2,800	
C. Facilities overhead	3,200	
Total Annual Recurring Costs	11,300	
III. Recurring Costs over four years ($11,300 X 4) -		45,200
IV. Total Four Year Costs		$112,398

V. Cost per workstation per hour of use:

$$\frac{\text{Total Four Year Costs}}{(\text{hours per week}) \times (\text{weeks per year}) \times (4 \text{ years} \times \text{no. units})}$$

$$\frac{\$112,398}{90 \times 40 \times 4 \times 20} = \frac{\$112,398}{288,000} = \$0.39 \text{ per hour}$$

To calculate the cost for each experimental section of approximately 25 students, multiply the amount of time required per student in the lab by the above figure and that by 25:

$\$0.39 \times 48 \times 25 = \$468.00$

Since the computing lab was not used exclusively by the students in the experimental sections of this course, the total annual costs of operation must be spread over all users. This formula also assumes full utilization; that is, that the facilities will be utilized 90 hours per week, 40 weeks per year for the full four years.

DISCUSSION AND CONCLUSIONS

This study reports the results of the second year of an investigation into the effects of the application of microcomputing technology and software in the instruction of freshman English composition. Three major areas of effect are examined:

1. Effect on students (cognitive effects)
2. Effect on faculty (pedagogic effects)
3. Effect on the university (financial effects)

An examination of the cognitive effects showed that both the control and experimental groups did experience a significant gain over the duration of the semester as measured by the Writing Skills Assessment and by the Houghton-Mifflin. When both the groups were compared against each other, there was no significant difference between the two groups on the posttest as measured by the Writing Skills Assessment.

However, when both groups were compared on the posttest Houghton-Mifflin scores, there was clearly a significant difference between the groups. In addition, the difference was in favor of the control group. Table 5 examined the distribution of score changes between the control group and experimental group. This table helps to explain the significant differences reported in Table 4. It was determined that, with a total n = 214, twenty-four percent of the experimental group and 16 percent of the control group had a decrease (pre-to-post) on the Houghton-Mifflin. The largest area of gain, and that which accounted for the most significant part of the overall gain for the control group was in the 11-20 point increase and the over 20 point gains. Here, the control group was clearly ahead of the experimental group.

From an examination of the pedagogic effects (Table 6) it is clear, for the second year, that instructors in the experimental sections put in a significantly longer amount of time in all activities as compared to the control sections. All areas examined (teaching, grading, class preparation,

student consultation) were significantly higher in the experimental group than in the control group. Overall, the difference amounted to about a 22 percent increase in amount of time spent in the experimental versus the control group.

Data for the financial effect this year took into consideration an increase in number of personal computer workstations and the addition of a facilities overhead (a sort of opportunity cost equivalent) which was not considered last year. In total, the average cost per workstation hour per student was $0.39, or $468 per semester for a section of 25 students. While these data by themselves are not particularly significant (other than reporting facts), they should be useful to others considering the application of similar technology.

In total, then, we found this year that the control group of students out-performed their experimental, word processing counterparts as measured by the standard Houghton-Mifflin College English Placement Exam. We found that instructors spend about 22 percent more time in total when using word processing in the freshman English program, and the added cost to the university was $18.72 per student.

In comparison with last year's cognitative data, the evaluation of the Writing Skills Assessment was similar, while the Houghton-Mifflin was reversed from last year's observations. Then the experimental group experienced significantly larger gains than did the control group.

While there was a slight improvement in the additional time required of instructors in experimental versus control sections this year, is was slight (22% versus 25% additional

time). The costs were also slightly lower this year per student contact hour with microcomputing equipment ($0.39 versus $0.50); this is largely due to the addition of workstations to the existing (and expensive) network controller and existing software. It simply reflects the relatively lower incremental costs of adding only workstations; in the long run, the cost curve for this type installation assumes a stair-step pattern, increasing in large amounts whenever the network controller must be purchased. Our best calculations indicate that one network controller can adequately support about 30 microcomputer workstations.

As this study is pursued this current year, several questions remain unanswered:

1. What can be done to reduce the heavy additional time required of faculty in teaching in the experimental environment?
2. Can the change in software bring about improved cognitive skills gains?
3. Are there additional/other indicators of student gains not now being considered?
4. Are there other extraneous variables that need to be controlled for?

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